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Snail communities associated to swampy meadows and sedgy marshy meadows plant communities of the Great Hungarian Plain

Comunidades de moluscos asociadas a comunidades vegetales de praderas pantanosas y junqueras en la Gran Llanura Húngara

Károly BÁBA* and István BAGI**

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ABSTRACT

Simultaneous phytocoenological, malacological and pedological studies were carried out in six successional plant community types characteristic on the Great Hungarian Plain. Data were analyzed by multivariate statistical methods (PCA). Variation in the abundance of ecological, habitat type and nutritional type species groups was also followed. In the *Succiso-Molinietum* (swampy meadows) and *Agrostio-Caricetum* (sedgy marshy meadows) plant communities, the distribution of constant and differential species is mostly influenced by their range of pH tolerance. Habitat drying and salinization, and various human impacts (draining, cutting and grazing by domestic animals) influence the succession of vegetation. Changes in snail assemblages include altering proportion of living and dead individuals and decreasing diversity (H'), both reflecting habitat drying and salinization. Complementary changes in the abundance of riparian and steppe dweller species groups indicate habitat drying, while swamp dwellers become more numerous as the topsoil becomes muddy due to salt accumulation. Concerning nutritional types, the proportion of omnivores decreases with habitat drying, whereas the frequency of herbivores increases in a complementary manner. The increasing abundance of saprophagous snails reflects biotope eutrophization caused by cutting and grazing.

RESUMEN

Se han desarrollado simultaneamente estudios fitocoenológicos, malacológicos y pedológicos en seis tipos de comunidades vegetales de la Gran Llanura Húngara. Los datos fueron analizados mediante métodos estadísticos multivariantes. También se ha estudiado la variación en los grupos de especies desde el punto de vista ecológico, de su hábitat y tipo nutricional. En las comunidades vegetales *Succiso-Molinietum* (praderas pantanosas) y *Agrostio-Caricetum* (junqueras), la distribución de las llamadas especies constantes y diferenciales está mayoritariamente influenciada por su rango de tolerancia de pH. La desecación del hábitat y su salinización, junto con un conjunto de alteraciones humanas (desecación, segado y ramoneado por animales domésticos) afectan la suceción vegetal. Los cambios en las comunidades de moluscos incluyen la variación en las proporciones de individuos vivos y muertos y una menor diversidad (H'); ambos cambios reflejan la desecación y salinización del hábitat. Cambios complementarios en la abundancia de los grupos de especies ribereñas y de estepa son indicadores de la desecación, mientras que las especies propias de zonas pantanosas se hacen más abundantes según la capa super-

* Department of Biology, Gy. Juhász Teacher Training College, Szeged, Hungary.
** Department of Botany, A. József University, Szeged, Hungary.

ficial se vuelve fangosa debido a la acumulación de sal. Por lo que se refiere a los grupos nutricionales, la proporción de omnivoros decrece con la desecación, mientras que la frecuencia de herbivoros crece de manera complementaria. La creciente abundancia de especies saprófagas refleja la eutrofización producida por el segado y ramoneo.

KEY WORDS: Gastropoda, drainage, salinization, species groups, succession, Hungary.
PALABRAS CLAVE: Gastropoda, desecación, salinización, grupos de especies, sucesión, Hungría

INTRODUCTION

Under the semiarid climate characteristic to the Eupannonicum floristic region (which the lowlands of the Carpathian Basin belong to), habitat drying and salinization processes were studied along a successional series spanning from swampy to salt-affected meadows. The *Succiso-Molinietum* association represents the wet meadows on calcareous swampy meadows soils. The physiognomy of its vegetation is determined by tall grasses (*Molinia caerulea, M. arundinacea, Festuca pratensis, Deschampsia caespitosa, Agrostis stolonifera*). Its stands have high species diversity and are rich in protected rare species (*Dactylorrhiza incarnata, Orchis laxiflora palustris, Cruciata pedemontana, Veratrum album, Iris spuria, I. sibirica, ...*). The *Succiso-Molinietum* is in successional relation to the *Agrostio-Caricetum* association; namely, moderate habitat drying and salinization involve its transformation into the latter. The *Agrostio-Caricetum* may occur independently, too. It is characteristic of the solontschak-solonetzic alkaline meadows soils. Depending on the hydro- and haloecological conditions the *Agrostio-Caricetum* forms various vegetation units (eg. subassociations), that well reflect the environmental impacts. These units are extremely diverse in its species composition and their physiognomy. The two associations represent the meadow formation of the Great Hungarian Plain in a significant percentage. As the two associations have evolved under wet conditions, the drought on their habitats causes drastical transformation in their vegetation structure, first of all in their species composition. The changes in the structure show close relationship to the environmental conditions, therefore every distinguished vegetation unit well reflects a stage of the drought induced vegetation transformation processes (phytocoenological indication). A lower proportion of data regards to other plant associations, that are in successional relationships with *Succiso-Molinietum* and *Agrostio-Caricetum*.

The water management works in the 20th century and the more and more arid climate of the last two decads endangered the vegetation of the wet meadows. Their transformation into drier habitats would have harmful consequences for the whole ecosystem, particularly the animal assemblages, that have no enough mobility to change their habitat. The terrestrial snails belong to a little mobile group of animals, they are bound to their habitats more firmly than other ones; therefore the, however well-known, successional and zonational relationships of the vegetation units can be examined on the basis of their snail assemblages, too. If the transformation processes of vegetation and their animal assemblages show paralelism, the changes in the composition of this animal group would have an indicative value for nature conservation.

MATERIALS AND METHODS

In the South-eastern part of the Great Hungarian Plain (Csongrád County) snail assemblages were sampled by the quadrat method. Ten plots 25 x 25 cm size were examined in parallel with phytosociological recording of each plant subassociation encountered (Soó, 1964). A hight proportion of the data regards to two plant communities: *Succiso-Molinietum* and *Agrostio-Caricetum*; only some samples originated other successionally related association. Altogether 30 collection sites were visited in six plant community types, while the number of subassociations studied was 22 (see Figure 3). In each quadrat, a detailed soil analysis was conducted, including measurements of relative percentage soil moisture, total organic matter content, $CaCO_3$ concentration, hygroscopy and pH.

The concepts applied in the coenological characterization are the following: Abundance (A) is the number of individuals of a snail species found in a plant community regarding to one m^2 (A/m^2); Dominance (D) is the ratio of individuals of a species related to the total individuals of every species; Species density (SD) is the average species number of 10 quadrats in a collection site; Frequency (F) is the ratio of a species in relation to the total number of species in a collection site (consist of 10 quadrats); Constancy (K) is the ratio of a species in relation to the number of all species found in all collection sites belonging to the same plant community. When a species was found in all the quadrats, it can be considered as an absolute constant species. D, F and K are expressed as percentages.

Data were analyzed by standardized Principal Components Analysis (PCA, Podani, 1988). Shannon-diversity (H'), SD and changes in the abundance (A/m^2) of living and dead individuals were followed through examination of the proportions of various species groups. Ecological species groups were defined as follows: S: sciophilous, P: swamp dweller, Ph: photophilous, R: riparian and OA: species of open areas. They were obtained by applying the block cluster method of Feoli and Orlóczi (1979). A simplified version of Ložek's (1964) typology was used and the following habitat type groups were distinguished: riparian ubiquitous (RU), bush forest dweller (B), hygrophilous swamp dweller (HP) and steppe dweller (ST). Nutritional type groups (O: omnivore, SP: saprophagous, H: herbivore) were differentiated after the system of Frömming (1954). Species and their group assignments are listed in Table I.

RESULTS AND DISCUSSION

Species encountered: Field studies yielded a collection of 3047 living and 3150 dead individuals belonging to 26 species (Table I). The majority of the specimens was found in the *Succiso-Molinietum* (1062 + 1268) and *Agrostio-Caricetum* (1496 + 1445) phytocoenoses, while plant associations 1, 3, 4 and 6 altogether contained 489 + 440 alive and dead individuals, respectively.

Two species new to the southern part of the Great Hungarian Plain were detected: *Malacolimax tenellus* (O. F. Müller, 1774) and *Deroceras sturanyi* (Simroth, 1894).

Characteristic species and their requirements: On the basis of frequencies of occurrence data, the constant, subconstant and accessorial species could be determined for the two plant associations most rich in snails (Table II). Constant and subconstant species reach low levels of dominance in both communities. This is probably due to unfavourable changes in their environment caused by either draining, drying, salinization or grazing. Differential species are *Cochlicopa lubricella* (Porro, 1938) and *Carychium minimum* O. F. Müller, 1774 in the *Succisio-Molinietum* plant association, and *Pupilla muscorum* (L., 1758) in the *Agrostio-Caricetum*. The occurrence of *Truncatellina*, *Granaria* and *Helicopsis* species in the *Agrostio-Caricetum* association indicates habitat drying. The distribution of constant and differential species is strongly influenced by the width of their pH tolerance range (Figs. 1, 2), as it has been shown earlier (Bába and Domonkos, 1992). According to aur data differential species of the *Succisio-Molinietum* association have a narrow pH tolerance range, in contrast with species occurring

Table I. Gastropod species found in the plant communities studied (1: *Caricetum acutiformis-ripariae*; 2: *Succiso-Molinietum*; 3: *Bolboschoenetum maritimae*; 4: *Astero-Agrostietum*; 5: *Agrostio-Caricetum distantis*; 6: *Achilleo-Festucetum pseudovinae*) E: Ecological species groups (S: sciophilous; P: swamp dweller; Ph: photophilous; R: riparian; OA: species of open areas); N: Nutritional type (O: omnivore; SP: saprophagous; H: herbivore); H: Habitat type (RU: riparian ubiquitous; B: bush forest dweller; HP: hygrophilous swamp dweller; ST: steppe dweller).

Tabla I. Especies de gasterópodos encontradas en las comunidades vegetales estudiadas (1: Caricetum acutiformis-ripariae*; 2:* Succiso-Molinietum*; 3:* Bolboschoenetum maritimae*; 4:* Astero-Agrostietum*; 5:* Agrostio-Caricetum distantis*; 6:* Achilleo-Festucetum pseudovinae*) E: Grupos ecológicos de las especies (S: esciófilo; P: de marisma; Ph: fotófilo; R: ribereño; OA: de áreas abiertas); N: Tipo nutricional (O: omnívoro, SP: saprófago, H: herbívoro); H: Tipo de hábitat (RU: ribereño ubiquo; B: zonas arbustivas; HP: marismeño higrófilo; ST: estepa).*

E	N	H		1	2	3	4	5	6
S	SP	R	*Carychium minimum* (O. F. Müller 1774)	17	5				
S	SP	HP	*Carychium tridentatum* (Risso 1826)		8				
OA	H	B	*Cepaea vindobonensis* (Ferussac 1821)		1	2		6	
OA	SP	ST	*Chondrula tridens* (O. F. Müller 1774)		135		1	388	50
R	O	B	*Cochlicopa lubrica* (O. F. Müller 1774)		3			4	
OA	O	ST	*Cochlicopa lubricella* (Porro 1838)	+	184				
R	O	RU	*Deroceras laeve* (O. F. Müller 1774)		1				
R	O	HP	*Deroceras sturanyi* (Simroth 1894)		1				
OA	O	B	*Euconulus fulvus* (O. F. Müller 1774)	4					
OA	H	ST	*Granaria frumentum* (Draparnaud 1801)	+				86	
OA	H	ST	*Helicella obvia* (Menke 1828)						3
OA	SP	ST	*Helicopsis striata* (O. F. Müller 1774)					1	
Ph	H	B	*Helix pomatia* (Linne 1758)					2	
S	O	RU	*Malacolimax tenellus* (O. P. Müller 1774)		1				
P	H	ST	*Monacha carthusiana* (O. F. Müller 1774)	18	99	13	5	195	25
R	H	RU	*Perforatella rubiginosa* (A. Schmidt 1853)		3				
OA	H	ST	*Pupilla muscorum* (Linne 1758)	1	1			329	165
R	O	RU	*Succinea oblonga* (Draparnaud 1801)	8	169	43	6	130	+
P	O	HP	*Succinea elegans* (Risso 1826)	1					
OA	SP	ST	*Trucatellina cylindrica* (Ferrusac 1807)					3	
OA	H	ST	*Vallonia costata* (O. F. Müller 1774)	1				8	6
R	O	P	*Vallonia enniensis* (Gredler 1856)	69	390			244	
R	SP	ST	*Vallonia pulchella* (O. F. Müller 1774)	19	40			55	17
R	SP	RU	*Vertigo antivertigo* (Draparnaud 1801)		1				
R	SP	ST	*Vertigo pygmaea* (Draparnaud 1801)	1	20			44	2
R	O	RU	*Zonitoides nitidus* (O. F. Müller 1774)	12				1	
			Number of Individuals	151	1062	58	12	1496	268
			Number of collection sites	1	11	1	1	15	1
			Number of Species	11	17	3	3	15	7
			Dead Individuals	155	1268	0	42	1445	243

in both *Agrostio-Caricetum* and *Succisio-Molinietum,* which tolerate a much wider range of soil pH (Fig. 2).

Successional changes: The ordination of snail samples of collection sites (1-30) clearly indicates (Fig. 3) the suc-

Table II. The constant (above), subconstant (middle) and accesorial (below) species of the two plant communities (*Succiso-Molinietum*, *Agrostio-Caricetum*) studied in more detail. K: constancy; D: dominance.

*Tabla II. Las especies constantes (arriba), subconstantes (medio) y accesorias (abajo) en las dos comunidades vegetales estudiadas (*Succiso-Molinietum, Agrostio-Caricetum*). K: constancia; D: dominancia.*

Succiso - Molinietum	K	D	*Agrostio - Caricetum*	K	D
Monacha carthusiana	100	9.32	*Chondrula tridens*	100	25.93
Succinea oblonga	90.9	15.91	*Monacha carthusiana*	100	13.03
Cochlicopa lubricella	81.81	17.32	*Succinea oblonga*	80	8.68
Vallonia enniensis	72.72	36.72	*Pupilla muscorum*	73.33	21.99
Chondrula tridens	72.72	12.72			
Vertigo pygmaea	45.45	1.88	*Vertigo pygmaea*	33.33	2.94
Carychium minimum	27.27	0.47	*Vallonia pulchella*	26.66	3.67
Vallonia pulchella	18.18	3.76	*Cepaea vindobonensis*	20	0.4
Cochlicopa lubrica	18.18	0.28	*Helix pomatia*	13.13	0.13
Carychium tridentatum	9.09	0.75	*Granaria frumentum*	6.66	5.74
Perforatella rubiginosa	9.09	0.28	*Vallonia costata*	6.66	0.53
Cepaea vindobonensis	9.09	0.09	*Cochlicopa lubricella*	6.66	0.26
Deroceras laeve	9.09	0.09	*Truncatellina cylindrica*	6.66	0.2
Deroceras sturanyi	9.09	0.09	*Helicopsis striata*	6.66	0.06
Malacolimax tenellus	9.09	0.09	*Zonitoides nitidus*	6.66	0.06
Pupilla muscorum	9.09	0.09			
Vertigo antivertigo	9.09	0.09			

cessional and zonational relationships of the plant associations studied, and a gradual habitat drying (BAGI, 1988). The main lines of the drying processes can be outlined as follows: (A) Non-salinic, wet line *Caricetum acutiformis-ripariae* (I, 1), *Succiso-Molinietum typicum* (II, 2-10), *S. -M. poetosum* (X, 11), *S. -M. agrostietosum* (XI, 12). The latter is a connection to a different, saline line: (B) *Bolboschoenetum maritimae* (IV, 14), *Agrostio-Caricetum bolboschoenetum* (IV, 21), *A. -C. fac. Juncus* (III, 16), *Agrostio-Caricetum plantaginetosum maritimae* (V, 17-20). Later, while the drying procces continues, the two lines originated a common line (C), whose representative associations are *A-C. festucetosum arundinaceae* (VI, 28), *A. -C. poetosum* (VIIa, 22-24), *A. -C. festucetosum pseudovinae* (VIII, 15) and finally the *Achilleo-Festucetum pseudovinae* (IX, 29). Roman numbers indicates groups of collection sites with similar features obtained from the analysis. The successionally closely connected plant communities often form zonation systems in the field. The drying processes have been particularly accelerated since the sixties, due to the draining of the region. The three successionally related lines could be distinguished in the process of draining-generated habitat drying by investigation of snails, too. The declining density of dead shells and living individuals, the fall of individual density (ID) and diversity (H') indicate habitat drying (X, V, VIIa, b, IX and VIII) and sometimes salinization (Fig. 4). Habitat drying accelerates with draining, which then leads to higher snail abundance again at the end of the successional xero-series at dry localities (*Achilleo-Festucetum* association). *Chondrula* and *Pupilla* can become especially numerous.

Snail species groups were used to evaluate these processes, for which the

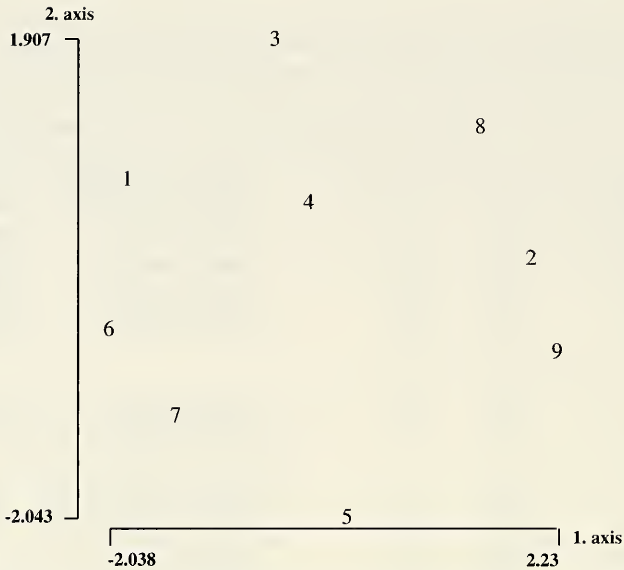

Figure 1. Distribution of constant and subconstant species according to soil pH (standardized PCA). 1: *Carychium minimum*; 2: *Succinea oblonga;* 3: *Cochlicopa lubricella*; 4: *Vertigo pygmaea*; 5: *Pupilla muscorum*; 6: *Vallonia costata*; 7: *Vallonia pulchella*; 8: *Vallonia enniensis*; 9: *Chondrula tridens.*

Figura 1. Distribucion de las especies constantes y subconstantes de acuerdo con el pH del suelo (Análisis de componentes principales estandarizado). 1: Carychium minimum*; 2:* Succinea oblonga*; 3:* Cochlicopa lubricella*; 4:* Vertigo pygmaea*; 5:* Pupilla muscorum*; 6:* Vallonia costata*; 7:* Vallonia pulchella*; 8:* Vallonia enniensis*; 9:* Chondrula tridens.

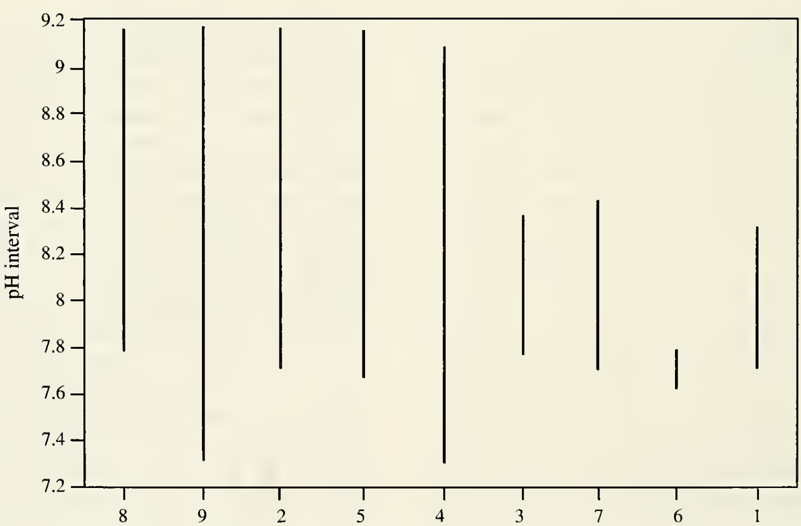

Figure 2. Distribution of the pH tolerance ranges of constant and subconstant species. Numbers refer to species as in Figure 1.

Figura 2. Distribución de los rangos de tolerancia al pH de las especies constantes y subconstantes. Los números de las especies son idénticos a los de la Figura 1.

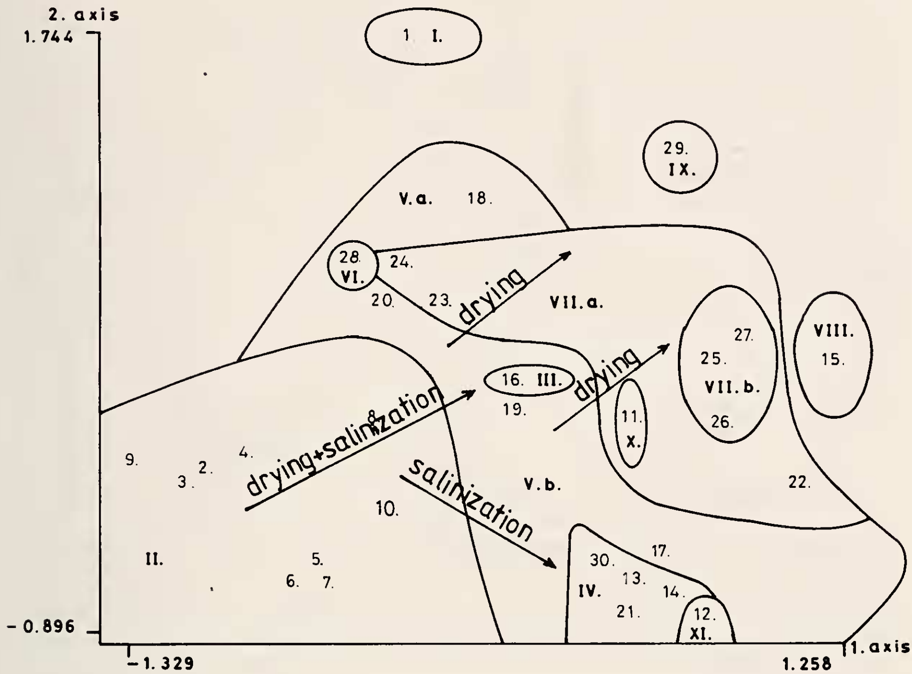

Figure 3. Ordination of collection sites by using data of snails samples (standardized PCA). Roman numbers indicate sample groups with similar phytological and malacological features; groups obtaines by ordination of data. Arabic numerals in brackets indicate collection sites. *Caricetum acutiformis-ripariae* I (1); *Succiso-Molinietum* a. *typicum* facies *Veratrum album* II (9), b. *typicum* facies *Phragmites* II (10), c. *typicum normale* II (2-8), d. *poetosum angustifoliae* X (11), e. *agrostietosum* XI (12); *Bolboschoenetum maritimae* IV (14); *Astero - Agrostietum* IV (30); *Agrostio - Caricetum distantis*, a. *agrostietosum* IV (13), b. *agrostietosum* facies *Juncus compressus* III (16), c. *plantaginetosum maritimae* Va, b (17-20), d. *poetosum angustifoliae* VIIa (22-24), e. *festucetosum arundinaceae* VI (28), f. *festucetusum pseudovinae* VII (15), g. *bolboschoenetosum* IV (20); *Achilleo - Festucetum pseudovinae* IX (29). See the text for further details.

Figura 3. Ordenación de las estaciones de muestreo utilizando datos de muestras de moluscos (Análisis de componentes principales estandarizado). Los números romanos indican grupos de estaciones con similares características fitológicas y malacológicas; los grupos se obtuvieron por ordenación de los datos. Los números arábigos entre paréntesis indican las localidades de muestreo. Caricetum acutiformis-ripariae *I (1);* Succiso-Molinietum *a.* typicum *facies* Veratrum album *II (9), b.* typicum *facies* Phragmites *II (10), c.* typicum normale *II (2-8), d.* poetosum angustifoliae *X (11), e.* agrostietosum *XI (12);* Bolboschoenetum maritimae *IV (14);* Astero - *NIV (30);* Agrostio - Caricetum distantis, *a.* agrostietosum *IV (13), b.* agrostietosum *facies* Juncus *NIII (16), c.* plantaginetosum maritimae *Va, b (17-20), d.* poetosum angustifoliae *VIIa (22-24), e.* festucetosum arundinaceae *VI (28), f.* festucetusum pseudovinae *VII (15), g.* bolboschoenetosum *IV (20);* Achilleo - Festucetum pseudovinae *IX (29). Véase el texto para más detalles.*

abundantial changes are shown (Figs. 5, 6, 7). Habitat drying and salinization have different consequences in the two plant associations. In the *Succiso-Molinietum* one, the abundance of riparian ubiquists (R, RU) monotonously decreases (collection sites 11 and 12 represent stages of ramification in the successional series). As the wet terrain dries down gradually, the abundance of species typical

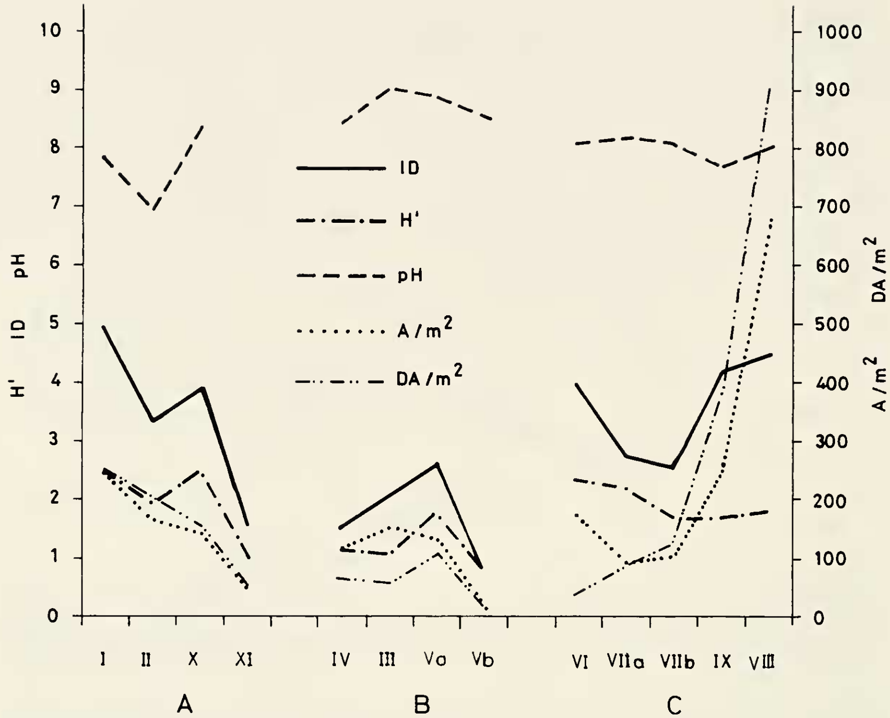

Figure 4. Variation in species density (ID), species diversity (H'), pH and density of living (A/m^2) and dead individuals (DA/m^2) in groups of phytocoenologically similar samples (Roman numerals) influenced by the dominant process of the habitat changes. A, B and C refer to the three succession lines of the vegetation. A includes groups I, II, X and XI; the main processes are drying (I, II and X) and salinization (XI). B includes groups IV, III and V; the main processes are drying (IV and III) and an additional salinization with cutting (Va, 18-20) and degradation (Vb, 17). C includes groups VI, VII, VIII and IX; the main processes are drying (VI, VIIa 22-24 and IX) with cutting (VIIb 25-27) and drainage (VIII).

Figura 4. Variación en la densidad de las especies (ID), diversidad (H'), pH y densidad de individuos vivos (A/m^2) y muertos (DA/m^2) en los grupos de muestras con características fitocoenológicas similares (números romanos) influenciadas por los procesos dominantes en los cambios de hábitat. A, B y C se refieren a las tres líneas de sucesión de la vegetación. A incluye los grupos I, II, X y XI; los principales procesos son la desecación (I, II y X) y la salinización (XI). B incluye los grupos IV, III y V; los principales procesos son la desecación (IV y III) y una salinización adicional con el segado (Va, 18-20) y degradación (Vb, 17). C incluye los grupos VI, VII, VIII y IX; los procesos principales son la desecación (VI, VIIa 22-24 y IX) junto con el segado (VIIb 25-27) y el drenaje (VIII).

in open areas (OA, ST) decreases, paralleled by a similar decline in the number of species and individuals (Figs. 5, 6). Concerning ecological species groups, the abundance of swamp dwellers (P, HP, *Monacha*) becomes higher with biotope salinization (12). Na^+ accumulation in the topsoil is responsible for its muddy character.

Sciophilous (S) and bush forest dweller (B) snail species may also appear in the tall and dense stands of *Caricetum acutiformis-ripariae* community. The abundance of OA and ST species groups increases at the end of the successional series in *Agrostio-Caricetum* and *Achilleo-Festucetum* associations. Groups P and HP are also more abundant there, due to

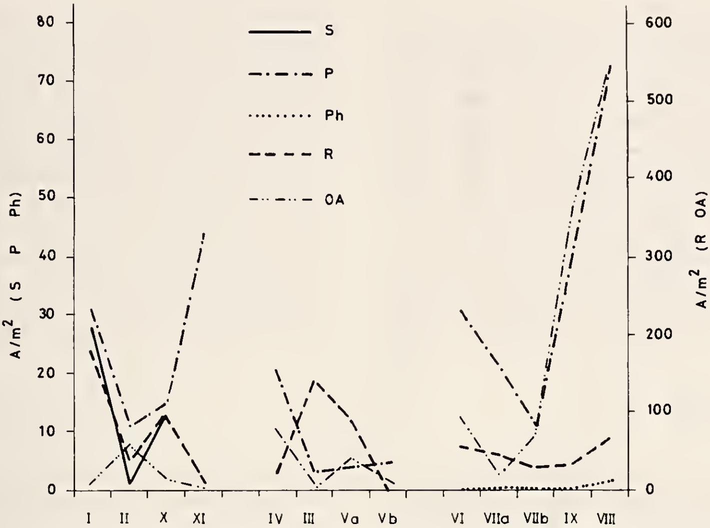

Figure 5. Variation in the abundance (A/m^2) of ecological snail species groups among plant associations and subassociations. Abbreviations, S: sciophilous, P: swamp dweller, Ph: photophilous, R: riparian and OA: species of open areas.

Figura 5. Variación en la abundancia (A/m^2) de los grupos ecológicos de especies de moluscos en el conjunto de las asociaciones y subasociaciones vegetales. Abreviaturas, S: esciófilo; P: de marisma; Ph: fotófilo; R: ribereño; OA: de áreas abiertas.

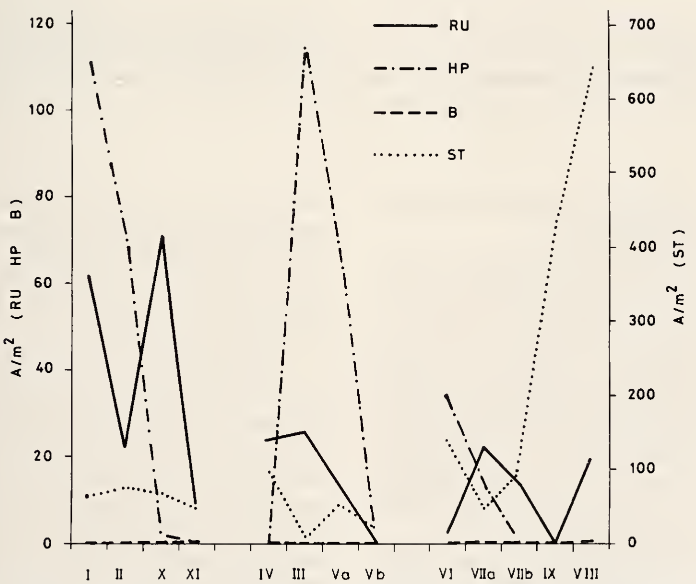

Figure 6. Variation in the abundance (A/m^2) of snail habitat type groups among plant associations and subassociations. Abbreviations, RU: riparian ubiquist, B: bush forest dweller, HP: hygrophilous swamp dweller and ST: steppe dweller.

Figura 6. Variación en la abundandia (A/m^2) de los tipos de hábitat en las especies de moluscos en el conjunto de las asociaciones y subasociaciones vegetales. Abreviaturas, RU: ribereño ubiquo; B: zonas arbustivas; HP: marismeño higrófilo; ST: estepa.

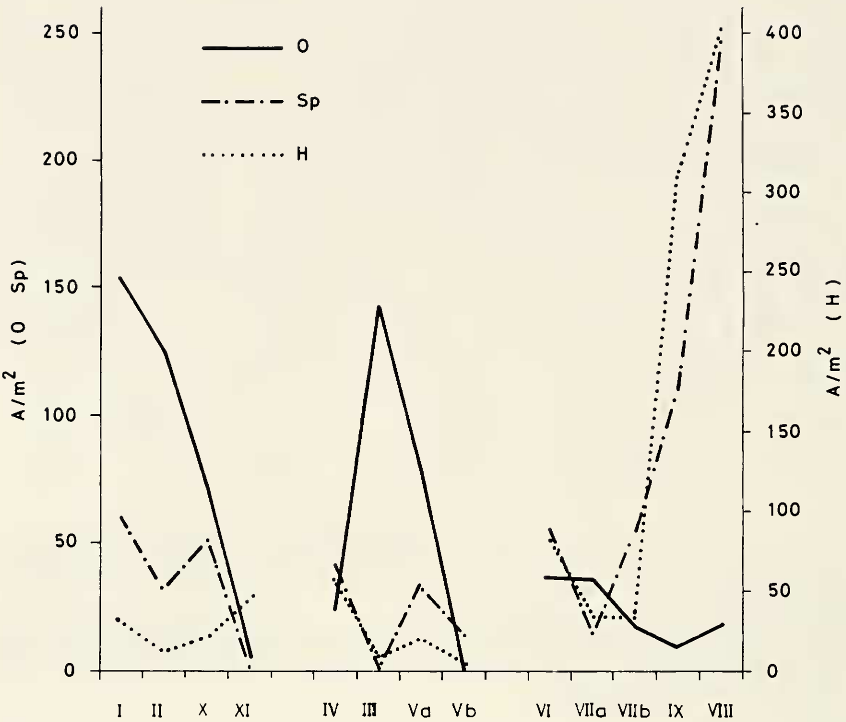

Figure 7. Variation in the abundance (A/m^2) of snail nutritional type groups among plant associations and subassociations. Abbreviations, O: omnivore, SP: saprophagous, H: herbivore.
Figura 7. Variación en la abundancia (A/m^2) de los grupos nutricionales de moluscos en el conjunto de las asociaciones y subasociaciones vegetales. Abreviaturas, O: omnívoro, SP: saprófago, H: herbívoro.

the muddy topsoil formed under Na^+ accumulation (Figs. 5, 6).

In both collection site groups of the *Agrostio-Caricetum* association, habitat salinization and drying, grazing and cutting result in the decline of the proportion of riparian ubiquists (R, RU: *Succinea*, *Vallonia pulchella*), and a complementary increase in the abundance of steppe dwellers (OA, ST: *Chondrula*, *Pupilla*). Stands of XI, Va and VIIa are regularly cut, while site of VIII is both cut and drained (Figs. 5, 6).

In terms of nutritional types, omnivorous snail species dominate in each collection site group, as it was also found elsewhere in willow-poplar forests (Bába, 1993). With habitat drying the vegetation becomes denser, resulting in a higher abundance of herbivores. Subsequent cutting increases the proportion of saprophagous species (*Vallonia, Chondrula, Vertigo*). The omnivore and herbivore-saprophagous groups were found to change in a complementary manner (Fig. 7).

According to our data, the connection between the vegetation units and the species groups of snails seems to be very close. The composition of snail assemblages indicates the most important environmental changes, such as drying and salinization, and the human impacts, eg. cutting, mowing and some other disturbances. The structural transformation of snail assemblages can be followed at a level of species groups and also within these groups. The snail assemblages indicate not only the differences between plant communities but the different impacts of natural and anthropogenic factors within a plant community as well. The consequences of the habitat drying are the decrease in species number and increase in abundance; the salinization causes the decrease of species number and change of species groups in a particular habitat. Mowing leads to the decrease of species number and increase of the ratio of saprophagous and steppe dweller species groups. The changes can be traced back to pedological reasons, eg. habitat drying, increase in pH value, and accumulation of organic matter. The investigations of the structural and compositional changes of snail assemblages of the studied six plant communities may provide a way to detect the consequences of the salinization as a characteristic successional process of Hungarian Great Plain. The studies on the changes of snail assemblages in meadow plant communities can indicate the main processes in this vegetatation type similar to the investigations carried in forest ecosystems (BÁBA, 1993).

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